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AGRICULTURAL EXPERIMENT STATION.

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INVESTIGATION OF CALIFORNIA ORANGES AND LEMONS.

A full investigation of the various fruits produced in California with respect to their proximate as well as ultimate composition, has long been contemplated at this Station; but the fewness of the available workers and the heavy demands made upon them in other directions has, until now, restricted this somewhat laborious branch of research to occasional tests, such as have heretofore been published in respect to particular lots of fruit sent for examination. With the increased force now at hand, it is proposed to investigate, as rapidly as may be, all the more important fruits produced on a commercial scale, so as to determine accurately the composition of the various kinds and varieties both with regard to food value and the draft made by them upon the store of plant food in the soils of the several regions. Since the latter vary very greatly in their nature, and therefore the replacement of the ingredients withdrawn by the crops will need to be made in accordance with the special requirements of each case in order not to "carry coal to Newcastle" at unnecessary expense, such investigations are of the most obvious practical importance; but at the same time they are extremely complex, and much time will be required to bring them to even a moderate degree of completeness.

The work here discussed was entered upon in response to the constant demand of growers of citrus fruits for information as to the most appropriate fertilizers to be used by them. While it is far from complete and will of course be continued and extended hereafter, it settles some of the immediately pressing questions.

In the execution of the work, Assistant Colby had the benefit of the very efficient aid of Mr. Hubert L. Dyer, a graduate of the University and post-graduate student in this department. Without such help, we would have had to remain satisfied with a much smaller number of analyses, and a much narrower basis for conclusions.

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commercial standpoint, as showing what is being purchased; for there can be no hesitation between an orange or lemon of average rind, pulp and juice and one of over one-third its weight of undesirable rind and one-quarter dry pulp.

The consumer, though usually considering fruit as a pure luxury, would derive much valuable knowledge from studying the orange in its relative value as a food. The nourishing portions, shown especially by the nitrogenous and saccharine contents, vary greatly with the variety and conditions of growth. It is not, then, a matter of indifference to the consumer what fruit he uses, but an important question of domestic economy.

The ash ingredients, together with the nitrogen contents of the standard varieties, are of high interest in connection with the vital question of soil exhaustion and fertilization. The soil ingredients extracted by an ordinary crop are a serious drain upon the supporting soil, and the lines of heaviest draft can only be determined by actual determination of the constituents withdrawn.

DESCRIPTION OF ORANGES AND LEMONS RECEIVED.

ORANGES.

NAVELS.

No. 1. *Marysville*—G. W. Hutchins, grower; sample received Jan. 22, '91. A large, fairly solid and heavy fruit, with rough thick skin, indented ribs and loose "rag"; juice only fair

*"Rag" is the white tissue between the pulp and skin proper.

The purpose of this work is to show comprehensively the proximate and ash composition of the leading varieties as grown in some of the principal citrus regions; and inferentially the influence exercised upon them by the prominent conditions of soil, climate, fertilizers, etc. The physical data (per cent of rind, pulp, juice, etc.) are of special interest from a com-

in amount, with pronounced acid and good flavor.

No. 2. *Niles, Australian?*—J. Shinn, grower; sample received March 30, '91. Undersized, rounded in shape, thick, loose skin and "rag," with tender pulp and pleasant acid.

No. 3. *Niles—Australian?* — J. Shinn, sample received May 19th. Fruit differed in shape, being both rounded and elongated; base ribbed; both skin and flesh remarkably tender, "rag" thick, only moderately juicy, but of very agreeable flavor. Both Australian (?) Navels were budded for Washington Navel by Mr. Shinn, who thinks, however, that the graft was taken from a sample tree of the Australian Navel.

No. 4. *Riverside Washington Navel*—From a box shipped to Prof. Hilgard by Dr. Jarvis; grower unknown, received Jan. 22d. Agrees well with description of typical Navel as given in Wickson's "California Fruits," p. 451.

No. 5. *Riverside*—R. W. Meacham grower; received May 12, '91. This orange was selected by a prominent nurseryman of Riverside in response to a request from this department. A large, thick-skinned orange with heavy "rag" and coarse pulp, much more elongated than typical Riverside Navel; some with base markedly depressed, or crater shaped, others flattened; acid medium.

No. 6. *Pomona*—Palmer and Shaw growers, April 10, '91. From tree six years old on hill land north of Pomona. An average sized fruit, high in color but with thick skin, heavy "rag" and broadened, fleshy base. On the whole a very desirable orange.

No. 7.—Selected by Shorb and Schwab of Pomona from a week's shipment as "over-size," received April 10, '91. From young trees (5 years) bearing only five or six oranges. Double the usual size and of correspondingly coarse structure although not unpleasant to the taste; decidedly "watery" as compared with Nos. 6 and 8.

No. 8. *Pomona*—L. M. Davenport grower; sample received April 10, '91. An average-sized and thin-skinned fruit of rather tender pulp and agreeable acid.

MEDITERRANEAN SWEET.

Nos. 9 and 10. *Smartsville* — Seedling resembling Mediterranean Sweet, Jas. O'Brien, grower; sample received Jan. 22, '91. Above medium size, light colored and smooth skin, acid very sharp. sample apparently not quite ripe.

No. 11. *Riverside*—R. W. Meacham, grower; May 12, '91. Somewhat elongated; color, yellowish-red; skin, thick and with sooty pits. Very juicy, pulp tender.

No. 12. *Pomona*—J. D. H. Browne, sender; May 5, '91. Rounded in shape, smooth and rather thick skin; "rag" coarse; pulp very juicy and slightly tart.

ST. MICHAEL'S.

No. 13. *Marysville*—G. W. Hutchins, grower; sample arrived Jan. 22, '91. Undersized as compared with those from Pomona and Riverside; medium heavy "rag" and rind; solid texture but pulp melting, and acid high.

No. 15. *Pomona*—Exhibit at Los Angeles Citrus Fair, sample received April 10, '91. A larger and less compact orange than the pre-

ceding; of very thin skin and tender pulp; acid, very pleasant. Two other samples from J. D. H. Browne were received a month later (May 5, '91); first, *paper rind* (No. 16) of round shape, smooth thin skin and very good flavor; second, (No 17) considerably larger than the first, skin thick; of elongated shape and agreeable taste.

No. 14. *Riverside*—R. W. Meacham, grower; sample received May 12, '91. Larger than the Pomona fruit but of the same general appearance, save that the skin is lighter colored; also of rather flatter taste, but very juicy.

MALTA BLOOD

No. 18. *Pomona*—Reeves, grower; sample arrived April 10, '91. Rather larger and more rounded than the typical specimen; skin moderately thick, pulp tender; seeds, none; acid remarkably sharp; juice, light red colored and of considerable quantity.

No. 19. *Pomona*—J. D. H. Browne, sender; May 5, '91. Agrees in size and shape with the previous sample but has a thinner skin and "rag"; acid less pronounced: pulp, melting.

No. 20. *Riverside*—R. W. Meacham, grower; May 12, '91. More elongated than those from Pomona and of rougher and thicker skin; base, heavy; "rag," porous; pulp, not quite so juicy but of deeper red color; somewhat "mushy," indicating over-ripeness.

VALENCIA.

No. 21. *Pomona*—J. D. H. Browne, sender; date of arrival May 5, '91. "Known here in So. Cal. as 'Valencia Late' or 'Rivers' or 'Rivers Late,' according to H. Van Deman identical with 'Hart's Late' in Florida. He is of the opinion that properly the name should be Nonpareil." About of the same size as the Mediterranean Sweet, but much larger than the St. Michaels' and of markedly elliptical form; smooth thin rind; "rag" of fine texture; pulp melting.

TANGERINE.

No. 22. *San Gabriel*—A. B. Chapman, grower; date of receipt April 11, '91. A small deep-colored fruit with loose thick rind and fibrous texture of pulp; taste very sweet; acid low, flavor peculiar (like garden balm) but agreeable.

SEEDLINGS.

No. 23. *Niles*—J. Shinn, grower; samples received May 19, '91. A large, round orange of light yellow color; base, ribbed and fleshy; heavy, tender skin; thick "rag," melting pulp, and exceedingly pleasant flavor. General appearance marred by *coast scale* and *fungus*.

LEMONS.

EUREKA.

Nos. 24 and 25. *Pomona and Ontario*—Two samples sent by Messrs. Short and Schwab, Pomona, April 10, '91. Of medium size and with light ribs; juice rather bitterish.

No. 26. *San Gabriel* — A. B. Chapman, grower; receipt of sample April 11, '91. Undersized; some markedly ribbed and with very thick skin; seeds small and undeveloped; flavor, more agreeable than in the preceding Eurekas.

ARROYO GRANDE PRIDE.

No. 27. *Arroyo Grande* — D. F. Newsom, grower; date of receipt April 22, '91. Undersized; smooth, heavy skin; bitterish to taste.

ANALYSES OF CALIFORNIA ORANGES AND LEMONS, CROP OF 1891.

A.—PROXIMATE ANALYSES.

ORANGES.															
Name of variety.....	Navel.								Mediterranean Sweet.				St. Michaels		
	Australian ?				Hill.				Yo'ng trees.					Seedling like Med. Sweet.	
														At pick'g	After 2 mos
Number.....	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.		
Place of production.....	Marysville.	Niles.	Niles.	Riverside	Riverside	Pomona.	Pomona.	Pomona.	Smartsville.	Smartsville.	Riverside	Pomona.	Marysville.		
Sender or grower.....	G. W. Hutchins.	J. Shinn.	J. Shinn.	Dr. Jarvis.	R. W. Meacham.	Palmer & Shaw.	Chosen by Short & Schwab.	L. M. Davenport.	J. O'Brien.	J. O'Brien.	R. W. Meacham.	J. D. H. Browne.	G. W. Hutchins.		
Date of receipt and analysis.....	Jan. 22.	Mar. 30.	May 19.	Jan. 22.	May 12.	April 10.	April 10.	April 10.	Jan. 26.	Mar. 26.	May 12.	May 6.	Jan. 22.		
PHYSICAL ANALYSIS.															
Average weight, in grammes.....	243.2	185.0	.....	222.3	378.3	373.0	680.0	294.3	180.0	124.5	214.5	212.0	125.2	
Rind, %.....	35.4	35.3	.....	17.5	34.2	29.5	31.0	18.6	23.9	14.4	31.1	27.2	21.9	
Pulp, less juice, %.....	25.0	27.7	.....	28.4	22.9	28.8	26.0	33.6	29.1	32.0	19.7	23.0	25.4	
Seeds, %.....	0.0	0.0	.....	0.0	0.0	0.0	0.0	0.0	2.0	2.7	1.1	3.3	2.4	
Number of c.c.m. juice, average.....	83.3	60.0	.....	105.0	142.5	122.5	215.0	127.5	71.6	54.8	90.0	96.6	62.0	
JUICE															
Solid contents by eridre, %.....	10.90	11.70	13.52	12.70	12.80	14.50	12.60	14.70	12.60	13.54	12.80	12.40	10.70		
Total sugars by copper (inversion), %.....	8.00	8.80	10.88	9.60	9.92	11.20	.....	11.10	10.09	10.33	9.50	9.80	7.90	
Cane sugar (polariscope), %.....	3.24	4.36	.....	4.32	.....	6.09	.....	5.77	4.14	4.77	.....	4.60	2.77
Acid (citric), %.....	1.14	1.05	1.16	1.01	.88	.77	.....	1.14	1.68	1.72	1.12	1.34	1.46	
Nitrogen in fresh fruit, %.....	.189	.....	.....	.245	.247	.197	.....	.180	.160	.....	.167	.145	.227
Albuminoids in fresh fruit, equivalent to nitrogen.....	1.18	.....	.....	1.53	1.54	1.23	.....	1.12	1.00	.....	1.05	.91	1.41
GENERAL PROXIMATE ANALYSIS.															
Water.....	85.56	.....	.....	85.24	83.50	85.00	.....	85.82	83.42	.....	85.83	85.72	84.10
Organic matter.....	13.04	.....	.....	14.31	13.11	14.59	.....	13.70	16.05	.....	13.6	13.80	15.42
Ash.....	.40	.....	.....	.45	.39	.41	.....	.48	.53	.....	.41	.48	.48
Total.....	100.00	.....	.....	100.00	100.00	100.00	.....	100.00	100.00	.....	100.00	100.00	100.00

130 grammes are equivalent to one ounce.

B—ANALYSIS OF THE ASH.

	ORANGES.												
Number.....	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.
Name of variety.....	Navel			Navel	Washington Navel.	Hill Navel.		Navel	Seedling like Med. Sweet.		Mediterranean Sweet.	Mediterranean Sweet.	St. Michaels.
Place of production.....	Marysville.			Riverside	Riverside	Pomona.		Pomona.	Smartsville.		Riverside	Pomona.	Marysville.
Raw ash % on fresh fruit.....	.554			.639	.538	.543		.660	.733		.550	.627	.657
Carbonic acid in raw ash.....	27.70			29.40	28.11	25.10		26.11	25.50		25.56	27.00	27.30
Pure ash fresh fruit, %.....	.399			.451	.386	.407		.483	.429		.413	.480	.477
COMPOSITION OF PURE ASH.													
Potash (K ₂ O).....	55.26			49.07		47.51			43.90		51.25		47.60
Soda (Na ₂ O).....	1.39			3.3		3.06			2.31		2.41		4.09
Lime (Ca O).....	16.37			26.42		17.50			27.77		18.78		24.70
Magnesia (Mg O).....	5.50			5.08		6.33			5.23		4.76		6.36
Peroxide of iron (Fe ₂ O ₃) and Alumina (Al ₂ O ₃).....	.41			.42		1.41			2.00		.62		1.18
Br. oxide manganese (Mn ₃ O ₄).....	.28			.44		.24			.18		.32		.40
Phosphoric acid (P ₂ O ₅).....	12.41			9.80		14.15			13.10		14.49		10.00
Sulphuric acid (S O ₃).....	6.81			4.23		7.91			4.34		5.58		4.84
Silica (Si O ₂).....	.56			.79		.98			.53		.85		.38
Chlorine (Cl).....	1.04			.63		1.00			.59		.92		.63
Less excess of Oxygen due to Chlorine.....	100.02			100.18		100.09			99.98		99.95		100.18
Total.....	.23			.13		.22			.12		.20		.13
Total.....	99.79			100.05		99.87			99.86		99.75		100.05

ANALYSES OF CALIFORNIA ORANGES AND LEMONS, 1891—CONTINUED.

A.—PROXIMATE ANALYSES—CONTINUED.

ORANGES.										LEMONS.				ORANGES.		LMS.	
St. Michaels.			Malta Blood.			Valencia.			Eureka.			AVERAGES.					
Paper rind.		Round.	Long.				Valencia.	Tangerine.	Seedling, Niles.				Arroyo Grande Pride.				
14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.				
Riverside	Pomona.	P. mona.	Pomona.	Pomona.	Pomona.	Riverside	Pomona.	San Gabriel.	Niles.	Pomona.	Ontario.	San Gabriel.	Arroyo Grande.				
R. W. Meacham.	Exhibit.	J. D. H. Browne.	J. D. H. Browne.	Reeves.	J. D. H. Browne.	R. W. Meacham.	J. D. H. Browne.	A. B. Chapman.	J. Shinn.	Short & Schwab.	Short & Schwab.	A. B. Chapman.	D. F. Newson.				
May 12.	April 10.	May 5.	May 5.	April 10.	May 5.	May 12.	May 5.	April 11.	May 19.	Ap il 10.	April 10.	April 11.	April 22.				
178.7	116.2	122.0	148.0	166.6	163.3	202.5	199.0	54.5	250.0	125.0	107.0	86.9	80.0	300	202	138	104
21.7	14.4	18.0	20.0	32.0	24.1	36.1	22.1	25.0	38.6	26.7	28.2	40.6	39.0	28.4	27	19.2	31
25.3	30.3	25.4	23.2	26.0	25.1	22.0	24.5	31.4	23.4	25.0	24.5	24.1	24.0	27.7	24	25.9	24
2.1	.8	1.9	1.1	0.0	0.0	0.0	.5	2.4	.6	.10	.2	.1	.1	.....	.8	1.6	.....
78.1	53.3	61.2	72.5	69.0	73.3	73.3	86.6	11.6	83.3	49.5	38.0	27.5	23.3	107	86	65.4	38
11.50	12.60	13.40	12.40	14.70	14.00	12.10	11.40	13.80	12.6	11.40	12.10	12.1	11.4	12.80	12.60	12.10	13.55
8.40	8.50	9.80	8.59	11.10	11.02	8.8	9.20	11.03	9.00	2.22	2.37	1.66	1.60	9.92	9.70	8.71	10.30
.....	4.2	.....	5.85	.....	.....	4.9	7.41	.....	.....	.58	.58	.56	.35	4.80	4.35	3.48	5.85
.84	1.03	1.27	1.15	2.14	1.57	1.23	1.12	.87	1.40	6.86	7.24	7.88	6.79	1.02	1.28	1.35	1.61
.230	.217	.....	.....	.115	.....	.221	.144	.155	.111	.172	.155	.128	.....	.211	.154	.228	.168
1.42	1.27	.....	.....	.75	.....	1.39	.90	.97	.69	1.07	.97	.80	.....	1.31	.96	1.43	1.05
86.49	83.69	.....	.....	84.50	.....	85.87	85.66	84.90	87.12	83.39	85.99	82.10	.....	.....	.....	.....	.....
13.15	15.75	.....	.....	15.05	.....	13.73	13.95	14.64	12.59	15.98	13.50	17.36	.....	.....	.....	.....	.....
.36	.56	.....	.....	.45	.....	.40	.39	.45	.29	.63	.51	.54	.....	.....	.....	.....	.....
100.00	100.00	.....	.....	100.00	.....	100.00	100.00	100.00	100.00	100.00	100.00	100.00	.....	.....	.....	.....	.....

B.—ANALYSIS OF THE ASH—CONTINUED.

ORANGES.										LEMONS.				ORANGES.	LMS.
14.	15.	16.	17.	18.	19.	20.	21.	22.	23.	24.	25.	26.	27.	AVERAGES.	
St. Michaels.	St. Michaels.			Malta Blood.		Malta Blood.	Valencia.	Tangerine.	Seedling, Niles.	Eureka.	Eureka.	Eureka.			
Riverside	Pomona.			Pomona.		Riverside	Pomona.	San Gabriel.	Niles.	Pomona.	Ontario.	San Gabriel.			
.538	.757	.....	.....	.664	.....	.529	.533	.612	.411	.928	.761	.744	.....	
33.25	26.51	.....	.....	31.12	.....	25.13	25.58	23.00	31.72	32.21	33.67	28.21	.....	
.360	.556	.....	.....	.454	.....	.397	.387	.461	.286	.632	.505	.535	.....	.432	.526
.....	45.82	.....	.....	52.20	.....	.....	.....	47.87	.....	45.32	.....	51.26	.....	48.94	48.26
.....	2.85	.....	.....	1.48	.....	.....	.....	1.67	.....	2.03	.....	1.50	.....	2.50	1.76
.....	27.36	.....	.....	19.07	.....	.....	.....	25.65	.....	34.07	.....	25.67	.....	22.71	29.37
.....	4.29	.....	.....	4.75	.....	.....	.....	5.48	.....	4.0	.....	4.80	.....	5.34	4.40
.....	.97	.....	.....	.84	.....	.....	.....	.94	.....	.28	.....	.18	.....	.97	.43
.....	.39	.....	.....	.64	.....	.....	.....	.45	.....	.28	.....	.28	.....	.37	.28
.....	12.99	.....	.....	14.71	.....	.....	.....	9.75	.....	10.19	.....	12.00	.....	12.37	11.09
.....	3.33	.....	.....	4.29	.....	.....	.....	5.36	.....	2.74	.....	2.94	.....	5.25	2.84
.....	.31	.....	.....	1.16	.....	.....	.....	.63	.....	.54	.....	.68	.....	.65	.65
.....	1.37	.....	.....	.95	.....	.....	.....	1.23	.....	.51	.....	.27	.....	.92	.39
.....	100.13	.....	.....	99.99	.....	.....	.....	100.03	.....	99.96	.....	99.92	.....	.....	.....
.....	.30	.....	.....	.20	.....	.....	.....	.27	.....	.11	.....	.05	.....	.....	.....
.....	99.83	.....	.....	99.79	.....	.....	.....	99.76	.....	99.85	.....	99.87	.....	99.98	99.98

The large table above shows the analytical work accomplished for this season (1891); subdivision A gives the physical and proximate analyses; B, the results of the analysis of the ash.

In order to bring out more clearly than is shown by the table the prominent points of similarity or difference, we discuss briefly the data presented.

ORANGES.

Proportion of Rind to Flesh.—Considering the matter first from the standpoint of the consumer, it seems that although the Navel is the largest of oranges it has, contrary to the popular impression, no advantage with respect to the proportion of skin to flesh over either the Mediterranean Sweet or St. Michaels. The average Navel can fairly be considered as containing nearly 72 per cent of flesh, while the average Mediterranean Sweet shows 73 per cent, the St. Michaels 81 per cent.

Juiciness or Proportion of Juice to Flesh.—A comparison of the figures in the table shows that of the named varieties examined the Navel is the driest, while the St. Michaels has the largest proportion of juice; the Mediterranean Sweet being next and the Malta Blood third.

These facts will be better understood by reference to the little table below, which gives the percentage ratios:

Proportion of Rind to Flesh.			Proportion of Pulp to Juice in Flesh.	
Averages.	Rind.	Flesh	Pulp.	Juice.
Navels.....	28.4	71.6	39	61
Med. Sweet.....	27	73	33	67
St. Michaels.....	19	81	31	69
Malta Blood.....	31	69	36	64

Evidently the hard and solid, although thin rind of the Navel weighs heavier in the balance than the more "corky" one of the Mediterranean Sweet and doubtless outweighs also that of many seedlings. No. 4 from Riverside and No. 8 from Pomona, however, show the lowest rind-percentage of any in the series, save No. 15, St. Michaels, Pomona, the genuine "paper rind." The study of the conditions contributing to thinness of rind will be of high commercial importance.

Sugar Contents of the Juice.—The table shows the maximum of sugar in the hill-grown Navel from Pomona (No. 6), but this is approached very closely by Navel No. 8, the Mediterranean Sweet No. 9, the Malta Blood from Pomona Nos. 18 and 19, and the Tangerine from San Gabriel No. 22. It is notable that the latter shows at the same time the highest proportion of cane sugar to be found in the whole series; the Pomona Navels and Malta Bloods standing next. To what extent the proportion of cane sugar determines the sweetness to the taste is a matter not yet fully understood; the proportion between the other two sugars (grape and fruit), not yet determined, being an essential factor in the case.

The average sugar contents of the fully ripe Navels (gathered in April and May) from all localities is 10.8 per cent. Against this we find Mediterranean Sweets from Riverside and Pomona (Nos. 11 and 12, gathered in May) to average 9.70 per cent only; while the Seedling from Smartsville, gathered in January, shows a little over 10 per cent, thus indicating a very early maturity.

The Valencia orange from Pomona (No. 21) shows a decidedly lower sugar percentage, as

does the contemporaneous Malta Blood from Riverside. The St. Michaels shows the lowest average of all the oranges (8.71 per cent), although the roundish sample from Pomona (No. 16) falls only a little below 10 per cent.

Comparing these data with those of previous years, heretofore published, we find that the sugar percentage of the Navel appears to have risen from 9.89 per cent to 10.80 per cent. For the Mediterranean Sweet the figure remains practically identical. For the St. Michaels it is higher than we have found it this season.

Acid in the Juice.—In respect to acid we note at once the maximum in the Malta Blood of over two per cent, with an average of 1.6 per cent in the three samples examined. The next highest figures occur in the early samples of Mediterranean Sweet from Smartsville, a maximum of 1.63 per cent; but the average of the May samples from Riverside and Pomona is 1.23 per cent. The St. Michaels of Marysville, Jan. 22d, shows the next highest maximum with 1.46 per cent, but in the later samples of April and May we find in the Riverside sample (No. 14) a minimum of .84 per cent with an average of 1.07 for the four later samples examined. In contrast to the Malta Blood, therefore, the St. Michaels counts among the varieties of low acid, combined, however, with rather a low sugar percentage, as stated above.

The Valencia rates in the same respect nearly with the St. Michaels, while the Tangerine shows the low figure of .87 per cent of acid with, at the same time, a very high sugar percentage. A former analysis showed for its close relative, the Mandarin, a lower minimum of acid (.36 per cent) and the highest sugar percentage on record, of 13.84 per cent.

The Navel justifies the statement made in a former report of the low acid percentage, even in samples gathered as early as January (Nos. 1 and 4), and still more in those of later date from Riverside and Pomona (Nos. 5 and 6). The minimum of all (.77 per cent) is shown by the Pomona fruit (No. 6), with, at the same time, the highest sugar percentage (11.20) of the series. In the aggregate, the average acid percentage of the Navel is the lowest of all, with the highest average of sugar, (9.92 per cent) outside of the Malta Blood. These data together with its firm flesh, thin and smooth rind, and excellent keeping qualities, explain sufficiently the great preference given it in our markets.

Comparing these results obtained in 1891, with those in previous publications of this department, 1879-1887, we note, first, an apparent increase in the average weight of the several varieties. We also find that while the percentages of rind show very nearly the same average as in 1891, there is a marked discrepancy in respect to juiciness, the pressed pulp averaging about 25 per cent less in earlier specimens. How far these differences may be due to influences of season or accident in sampling, is difficult to decide with the data before us; the more as the acid and sugar percentages show very nearly the same absolute as well as relative figures. Increased age of the bearing trees may possibly account for some of these differences.

No. 7 is interesting as showing just how an abnormally large orange differs from the ordinary fruit. It is markedly "watery" as compared with fruit of normal size.

Nos. 9 and 10 are of special interest, since they

show the changes produced in an orange by two months storage. There is a considerable loss in weight, which is found in the diminished weights of rind and flesh. Both the sugar and acid contents have increased, the former so appreciably as to warrant the conclusion that the fruit was sweetened by keeping, apart from evaporation. It was noted on receipt of No. 9 that the sample was not thoroughly ripe, and the taste of the same fruit two months later was decidedly better.

Nutritive Values—Nitrogen contents—The flesh-forming ingredients (albuminoids) of any article of food being of great importance as regards its proper uses, it is of special interest to compare in this respect the orange to other fruits, and the different varieties of oranges amongst themselves. According to the latest European data oranges stand first in the amount of albuminoids (1.73 per cent.), pines second (.78 per cent), peaches (and probably apricots) third, bananas and grapes fourth, while apples and pears stand nearly the lowest on the list (.375 per cent). Our determinations of the same substances in California oranges as a whole (rind included) show materially smaller figures, averaging 1.20 per cent; and as it is known that the rind is very poor in these substances, we are forced to conclude that the California fruit is less nourishing than that of Sicilian production. Much lower percentages, however are quoted for oranges from other sources. Here, again, the differences observed may be largely due to the age of the trees bearing the fruit, which in California is usually the minimum.

Of the entire series the Riverside Navels (Nos. 4 and 5) show the highest contents of albuminoids (1.54 per cent), while the average of the Pomona sample is 1.18 per cent only. Next highest to the Riverside Navel's come the St. Michaels from Marysville, Riverside and Pomona, with an average 1.40 per cent; nearly the same is shown by the Riverside Malta Blood. The average of the Mediterranean Sweets falls below 1.0 per cent, that from Pomona falling to .91 per cent. The Malta Blood and Niles seedling show the minima of .69 per cent and .75 per cent. The Valencia and Tangerine, with the Eureka lemon, seem to range about 1.0 per cent.

Ash Composition, and Nitrogen contents—As will be seen by reference to Bulletin No. 88, of the department, the orange stands second (grapes being first) among orchard fruits in the quantity of mineral matter withdrawn from the soil. Heretofore, we have been obliged to base all conclusions bearing upon the ash and nitrogen of these fruits on European data; we are now enabled to present for oranges and lemons the outcome of California growth. The following summary (based on averages from the large table) shows in tabular form the amounts, in pounds, of the soil ingredients extracted by an orange or lemon crop, that will have to be replaced by fertilization.

ORANGES	Total Ash, lbs.	Potash, lbs.	P. Phos. Acid, lbs.	Nitrogen, lbs.
EUROPEAN (seedless)				
Crop of 1000 lbs.....	6.07	2.78	.67	2.69
Crop of 20,000 lbs....	121.4	55.60	13.40	53.80
CALIFORNIA				
Crop of 1000 lbs....	4.32	2.11	.53	1.83
Crop of 20,000 lbs....	80.40	40.14	10.60	36.69
LEMONS				
Crop of 1000 lbs.....	5.57	2.69	.61	1.51
Crop of 20,000 lbs..	111.40	53.80	12.20	31.20

It thus appears that so far as oranges are concerned, the California fruit draws materially less upon all the soil ingredients that have to be replaced by fertilization; while as regards the lemon, it approaches closely to the European standard for the orange, save in the much smaller draft upon nitrogen.

There is of course no material difference in the relative proportions of ash ingredients among themselves, or toward nitrogen.

Potash is seen to be the predominating ingredient amounting to quite half of the weight of the ash; it is, therefore, highly important that the supply of this substance should be kept up; but fortunately, as has been shown by previous investigations of this department, the supply of this substance in California soils and irrigation waters is exceptionally large; so that in many cases the current demand for the fruit will be amply supplied in the ordinary course of cultivation.

Phosphoric acid is not so heavily drawn upon; but as it is usually present in our soils in limited quantities only, it is probable that it should constitute large proportion of any fertilizer used in the orange orchard.

Of **nitrogen** nearly the same may be said as regards the natural supply, especially in southern mesa soils; but as the draft made by the orange upon this substance is very heavy it will always be among the first to be currently supplied.

As regards other ash ingredients, it will be seen that **lime** is the one most heavily drawn upon next to potash, although its percentage varies rather widely (from 16.37 per cent to 27.77 per cent for oranges.) The supply of lime in California soils is almost universally so ample within the orange-growing region, that no replacement of this substance in fertilization will be called for.

The not inconsiderable demand of the orange for sulphuric acid, as seen in the table, suggests that gypsum will be acceptable in this as in other respects, as a fertilizing ingredient.

A further discussion of the ash ingredients would not be profitable at this place.

LEMONS.

The incompleteness of the data concerning lemons renders it inadvisable to enter upon any extended discussion, the more as no extended data from the old world are available for comparison. It will be noted that the most important ingredient of this fruit, viz., the acid percentage, considerably exceeds for the Eureka lemon, at least, the commonly assumed average, and in the case of No. 26, from San Gabriel, the acid percentage is extraordinary. This point alone should insure to California-grown lemons a high position in commerce.

The relatively large percentage of sugar shown by the analyses is a feature which will further commend them to the consumers taste as against the percentages usually reported. It will be observed, however that very great differences exist in the proportion of rind to flesh and extractable juice. In this respect the lemons of Pomona and Ontario stand at the head of the list as far as it goes.

In ash composition there is no material difference between the orange and lemons examined; with a more extended series the variations in both would doubtless be shown to run parallel.

Berkeley, June, 25, 1891.

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